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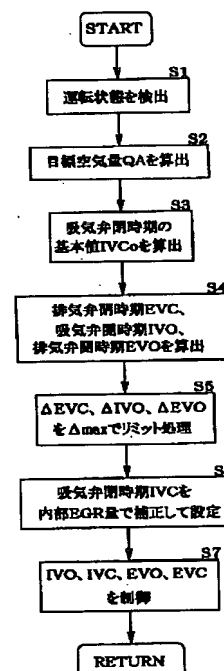
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(54)【発明の名称】 可変動弁の制御装置

(57)【要約】

【課題】エンジンの過渡性能を向上する。

【解決手段】電磁駆動式の吸・排気弁を備えたエンジンで、目標空気量QAに応じて吸気弁の開時期の基本値 IVCoを算出し (S1~S3)、排気弁の開時期EVC、吸気弁の開時期IVO、排気弁の開時期EVOを算出した後、 $\Delta EVC$ 、 $\Delta IVO$ 、 $\Delta EVO$ を $\Delta max$ でリミット処理 (S4、S5)、前記IVCを内部EGR量で補正して設定した後、IVO、IVC、EVO、EVCを制御する。これにより、吸気弁開時期以外のバルブタイミングの変化速度が吸気弁開時期の変化速度より小さくなり、過渡時のトルク性能が向上する。



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## 【特許請求の範囲】

【請求項 1】 エンジンの吸・排気弁の開閉時期を任意に可変制御できる可変動弁の制御装置において、吸気弁の開時期、排気弁の開時期及び閉時期の変化速度を、吸気弁の閉時期の変化速度より小さい値に設定したことを特徴とする可変動弁の制御装置。

【請求項 2】 吸気弁の開時期、排気弁の開時期及び閉時期の変化速度に上限値を設けたことを特徴とする請求項 1 に記載の可変動弁の制御装置。

【請求項 3】 吸気弁の開時期、排気弁の開時期及び閉時期の変化速度に設けた上限値を、吸気弁の閉時期に設けた変化速度の上限値より小さくしたことを特徴とする請求項 1 に記載の可変動弁の制御装置。

【請求項 4】 吸気弁の開時期、排気弁の開時期及び閉時期算出の平均化度合いを、吸気弁閉時期より大きくしたことを特徴とする請求項 1 に記載の可変動弁の制御装置。

## 【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、電磁駆動式など開閉時期を任意に可変制御できる吸・排気弁を備えた可変動弁エンジンのトルクを調整する制御装置に関する。

【0002】

【従来の技術】 従来一般のエンジンでは、スロットル弁の開度によって吸入空気量を制御するが、近年、電磁駆動式の吸・排気弁を備え、主として吸気弁の閉時期の制御によって吸入空気量を制御するようにしたものが提案されている（特開平 10-37727 号公報参照）。

【0003】 この種の吸入空気量制御では、スロットル弁を備えない場合は略大気圧に維持される吸気圧力、またスロットル弁を併用する場合はスロットル弁開度に応じた吸気圧力に対し、吸気弁の閉時期により決定される有効吸気行程に応じたシリンダ吸入空気の体積量を制御することで、要求トルクに応じた目標空気量を得るように制御することができる。

【0004】

【発明が解決しようとする課題】 しかしながら、正確には燃焼室内の残留ガス量に応じて目標空気量を得るための吸気弁閉時期が変化し、残留ガス量が多くなるほど閉時期を吸気下死点に近づけて有効吸気行程を増大する必要がある。したがって、残留ガス量を決定する排気弁の閉時期と吸気弁の開時期を考慮して（より正確には排気弁の開時期をも考慮して）、吸気弁の閉時期を算出することが要求される。

【0005】 その場合、吸・排気弁の各バルブタイミングの制御を均等に行うと、例えば残留ガス量の変化に対し、吸気弁閉時期以外の排気弁の閉時期と吸気弁の開時期、さらには排気弁の開時期を含めた吸気弁の閉時期以外の制御の方が、吸気弁の閉時期の制御より応答性良く実行されると、吸気弁の閉時期が目標値に制御されるま

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での過渡時におけるトルクのずれが大きくなり、良好な運転性を確保できないことがあった。

【0006】 例えば、内部 EGR 率を一定に維持しながら吸入空気量を増大する制御を行う場合、吸気弁の開時期と排気弁の閉時期、更には排気弁の開時期を変更しつつ、吸入空気量の増大分に内部 EGR 量（残留ガス量）の増大分を考慮して、吸気弁の閉時期を遅らせる制御を行うことになるが、吸気弁の開時期、排気弁の閉時期及び排気弁の開時期の変化に対して吸気弁の閉時期の変化が遅れると、残留ガス量の増大に対して吸入空気量が不足し、トルク不足となってしまう、運転性が大きく低下してしまう。

【0007】 即ち、内部 EGR 量（残留ガス量）の変化に追従して常に最適な空気量（新気量）を確保できるように、内部 EGR 量（残留ガス量）を決定する吸気弁の開時期と排気弁の閉時期、さらには排気弁の開時期の制御の応答性を、吸気弁の閉時期制御の応答性より低くする必要がある。

【0008】 本発明は、このような従来の課題に着目してなされたもので、吸・排気弁の各バルブタイミングの応答性を適切に設定することにより、良好な過渡性能が得られるようにした可変動弁の気量制御装置を提供することを目的とする。

【0009】

【課題を解決するための手段】 このため、請求項 1 にかかる発明は、エンジンの吸・排気弁の開閉時期を任意に可変制御できる可変動弁の制御装置において、吸気弁の開時期、排気弁の開時期及び閉時期の変化速度を、吸気弁の閉時期の変化速度より小さい値に設定したことを特徴とする。

【0010】 請求項 1 に係る発明によると、吸気弁の開時期、排気弁の開時期及び閉時期の目標値を変更すると、該変更に応じた残留ガス量の変化に応じて吸気弁の閉時期の目標値も変更されるが、吸気弁閉時期以外の残留ガス量の変化に関与するバルブタイミングの変化速度が吸気弁の閉時期の変化速度より小さく制御される。

【0011】 これにより、残留ガス量の変化に追従して目標空気量を最適値に維持する制御を行なうことができ、過渡時にも高精度な吸入空気量制御ひいてはトルク制御を行なうことができ、急激なトルク変化を回避でき良好な運転性を維持できる。

【0012】 また、請求項 2 に係る発明は、吸気弁の開時期、排気弁の開時期及び閉時期の変化速度に上限値を設けたことを特徴とする。

【0013】 請求項 2 に係る発明によると、吸気弁の開時期、排気弁の開時期及び閉時期の変化速度は、上限値により規制されることで、吸気弁の閉時期の変化速度より小さく制御される。

【0014】 また、請求項 3 に係る発明は、吸気弁の開時期、排気弁の開時期及び閉時期の変化速度に設けた上

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限值を、吸気弁の開時期に設けた変化速度の上限値より小さくしたことを特徴とする。

【0015】請求項3に係る発明によると、吸気弁の開時期、排気弁の開時期及び閉時期の変化速度は、これら変化速度の上限値が吸気弁の開時期の変化速度の上限値より小さく設定されることにより、吸気弁の開時期の変化速度より小さく制御される。

【0016】また、請求項4に係る発明は、吸気弁の開時期、排気弁の開時期及び閉時期算出の平均化度合いを、吸気弁閉時期より大きくしたことを特徴とする。

【0017】請求項4に係る発明によると、ノイズ等による過渡的な変動を回避するため制御目標値に対して平均化処理を行うと、目標値への収束に遅れを有し、吸気弁の開時期、排気弁の開時期及び閉時期の算出の平均化度合いを、吸気弁閉時期より大きくすることにより、目標値への収束の遅れが大きくなる。

【0018】これにより、吸気弁の開時期、排気弁の開時期及び閉時期の変化速度を、吸気弁閉時期の変化速度より小さくすることができる。

【0019】

【発明の実施の形態】以下に本発明の実施の形態について説明する。図1は本発明の一実施形態を示す可変動弁の制御装置を備えたエンジンのシステム図である。

【0020】エンジン1の各気筒のピストン2により画成される燃焼室3には、点火栓4を囲むように、電磁駆動式の吸気弁5及び排気弁6を備えている。7は吸気通路、8は排気通路である。

【0021】吸気弁5及び排気弁6の電磁駆動装置（吸・排気弁と共に可変動弁を構成する）の基本構造を図2に示す。弁体20の弁軸21にプレート状の可動子22が取付けられており、この可動子22はスプリング23、24により中立位置に付勢されている。この可動子22の下側に開弁用電磁コイル25が配置され、上側に閉弁用電磁コイル26が配置されている。

【0022】そして、エンジン1の始動前にこれら開弁用電磁コイル25及び閉弁用電磁コイル26を交互に通電して可動子22を共振させ、振幅が十分大きくなったところで、いずれかの電磁コイルに可動子22を吸着保持する。

【0023】その後は、閉弁から開弁させる際は、可動子22を吸着している上側の閉弁用電磁コイル26への通電を停止した後、スプリング23の付勢力で可動子22を下方に移動させ、下側の開弁用電磁コイル25に十分接近したところから該開弁用電磁コイル25に通電して可動子22を吸着することにより、弁体20をリフトさせて開弁させる。

【0024】逆に、開弁から閉弁させる際は、可動子22を吸着している下側の開弁用電磁コイル25への通電を停止した後、スプリング24の付勢力で可動子22を上方へ移動させ、上側の閉弁用電磁コイル26に十分接

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近したところから該閉弁用電磁コイル26に通電して、可動子22を吸着することにより、弁体20をシート部に着座させて閉弁させる。

【0025】図1に戻って、吸気通路7には、各気筒毎の吸気ポート部分に、電磁式の燃料噴射弁9が設けられている。ここにおいて、吸気弁5、排気弁6、燃料噴射弁9及び点火栓4の作動は、コントロールユニット10により制御され、このコントロールユニット10には、エンジン回転に同期してクランク角信号を出力しこれによりエンジン回転速度を検出可能なクランク角センサ11、アクセル開度（アクセルペダルの踏み量）を検出するアクセルペダルセンサ12等から、信号が入力されている。

【0026】そして、アクセル開度、エンジン回転速度等のエンジンの運転条件に基づいて目標トルクを発生し、かつ、排気エミッション特にNO<sub>x</sub>排出量低減のため、運転条件に応じて適度な内部EGR量に制御されるように、吸気弁5と排気弁6の目標開閉時期が設定され、該目標開閉時期が得られるように吸気弁5、排気弁6の開閉時期が制御される。

【0027】また、前記各種センサ類により検出された値に基づいて、吸入空気量が検出され、該吸入空気量に基づいて前記燃料噴射弁9からの燃料噴射量が制御される。以下に、本発明に係る吸・排気弁の開閉時期制御の第1の実施形態を、図3のフローチャートに従って詳細に説明する。

【0028】ステップ1では、アクセルペダルセンサ12によって検出されたアクセル開度及びクランク角センサ11によって検出されたエンジン回転速度等を読み込んで、エンジン1の運転状態を検出する。

【0029】ステップ2では、前記検出された運転状態に基づいて、要求トルクに見合った目標空気量QAを算出する。ステップ3では、前記目標空気量QAを得るための吸気弁5の開閉時期の基本値IVCOが設定される。該基本値IVCOは、内部EGR量（残留ガス量）を考慮しない値として設定される。

【0030】ステップ4では、前記検出された運転状態に基づいて、内部EGR量を適量に制御するべくバルブオーバーラップ量を決定する排気弁6の閉時期EVCと吸気弁5の開時期IVOとを設定し、さらに、該排気弁6の閉時期EVCに合わせて必要な排気弁6の開期間が確保されるように排気弁6の開時期EVOが設定される。なお、排気弁6の開時期EVOも排気（掃気）効率に関連して内部EGR量に関連する。

【0031】ステップ5では、前記IVO、EVC、EVOの前回設定値からの変化量ΔIVO、ΔEVC、ΔEVOが、上限値Δmaxを超えないように変化量を制限するリミット処理を行う。

【0032】ステップ6では、前記運転状態に応じた内部EGR量を考慮して前記吸気弁5閉時期の基本値IV

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C<sub>o</sub>を補正した閉時期IVCを設定する。ステップ7では、上記のようにして設定された吸気弁5の閉時期IVCと、リミット処理された排気弁6の開時期EVO及び閉時期EVCと吸気弁5の開時期IVOに応じた制御信号を出力して、吸・排気弁の開閉時期を制御する。

【0033】このようにすれば、内部EGR量に関する排気弁6の開時期EVO及び閉時期EVCと吸気弁5の開時期IVOについては、上限値 $\Delta_{\max}$ によるリミット処理により、吸気弁5の閉時期IVCに比較して変化速度が遅く制御されることになる。

【0034】図4は、加減速時の制御例を示し、加速時に排気弁6の開時期EVO及び閉時期EVCを5°ずつ遅角し、吸気弁5の開時期IVOを5°進角させてバルブオーバーラップ量を10°増大すると共に、吸気弁5の閉時期IVCを20°遅角する制御を行い、その後各バルブタイミングを加速前の値に戻して減速を行ったものである。

【0035】図示実線に示すように、吸気弁5の閉時期IVCの変化速度の方を、それ以外のバルブタイミングIVO、EVC、EVOの変化速度より大きくすること  
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で、過渡状態でもIVO、EVC、EVOの変化にIVCが良好に追従しながら最終目標値に収束させることができる。また、仮に過渡時にトルク感度の大きい吸気弁5の閉時期IVCの変化が、それ以外のトルク感度の小さい各バルブタイミングの変化より早過ぎることがあったとしても、要求トルクの増減方向に一致する方向で大きめとなるだけなので違和感がない。逆に、過渡時に吸気弁5の閉時期IVCの変化が、それ以外の各バルブタイミングIVO、EVC、EVOの変化より遅いと、一旦要求トルクの増減方向と逆向きの方向に制御されること  
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になるので、違和感が大きい（図示一点鎖線参照）。特に要求トルクが増大しているにもかかわらず、残留ガスの増大に吸気弁閉時期の制御が遅れて実際のトルクが減少してしまうことは、大きな問題であるが、本発明では、このような問題を回避できる。

【0036】次に、本発明に係る吸・排気弁の開閉時期制御の、第2の実施形態のフローを図5に示す。ステップ1～ステップ6は図3と同様であり、異なるのは、ステップ11において、ステップ6で設定された吸気弁5の閉時期の前回設定値に対する変化量 $\Delta IVC$ に対して  
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も上限値 $\Delta_{\max 2}$ を超えないように変化量を制限するリミット処理を行うが、該 $\Delta IVC$ の上限値 $\Delta_{\max 2}$ は、ステップ5において変化量 $\Delta IVO$ 、 $\Delta EVC$ 、 $\Delta EVO$ に対して設定される上限値 $\Delta_{\max}$ より大きい値に設定されている点である。

【0037】このように、 $\Delta IVC$ の上限値 $\Delta_{\max 2} > \Delta IVO$ 、 $\Delta EVC$ 、 $\Delta EVO$ の上限値 $\Delta_{\max}$ としても、吸気弁5の閉時期以外のバルブタイミングの変化速度を、吸気弁5の閉時期の変化速度より小さく制御できるため、過渡時においても高精度なトルク制御を行なう  
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ことができ、また、 $\Delta IVC$ もリミット処理することで、急激なトルク変化を抑制して、滑らかな運転性能を確保できる。

【0038】また、吸気弁5の閉時期IVCの目標値への収束と、それ以外のバルブタイミングIVO、EVC、EVOの目標値への収束が略同時に行われるように、各バルブタイミング毎に、目標値の変化量に対して上限値を比例的に設定する構成としてもよい。

【0039】図6は、本発明に係る吸・排気弁の開閉時期制御の、第3の実施形態のフローを示す。この実施形態では、リミット処理の代わりに、ステップ4'での吸気弁5の開時期IVO、排気弁6の閉時期EVC及び開時期EVOの算出時と、ステップ6での内部EGR量に応じた吸気弁5の閉時期IVCの補正後のステップ21において、ノイズ等による過渡的な変動を回避するため加重平均演算等の平均化処理を行うが、吸気弁5の開時期IVO、排気弁6の閉時期EVC及び開時期EVOの算出における平均化度合い（なまし度合い）を、吸気弁5の閉時期IVCの算出における平均化度合いより大きくする（加重平均演算の場合過去の値に対する重みを、より大きくする）。

【0040】このように平均化処理を行うと、目標値への収束に遅れを有し、吸気弁5の開時期IVO、排気弁6の開時期EVO及び閉時期EVCの算出の平均化度合いを、吸気弁5の閉時期IVC算出の平均化度合いより大きくすることにより、目標値への収束の遅れが大きくなり、吸気弁5の開時期IVO、排気弁6の開時期EVO及び閉時期EVCの変化速度を、吸気弁5閉時期IVCの変化速度より小さくすることができ、第1、第2の実施形態と同様の効果が得られる。

#### 【図面の簡単な説明】

【図1】 本発明の一実施形態を示す可変動弁の制御装置を備えたエンジンのシステム図。

【図2】 吸・排気弁の電磁駆動装置の基本構造図。

【図3】 吸・排気弁の開閉時期制御の第1の実施形態のフローチャート。

【図4】 加減速制御時の各バルブタイミングの様子を示すタイムチャート。

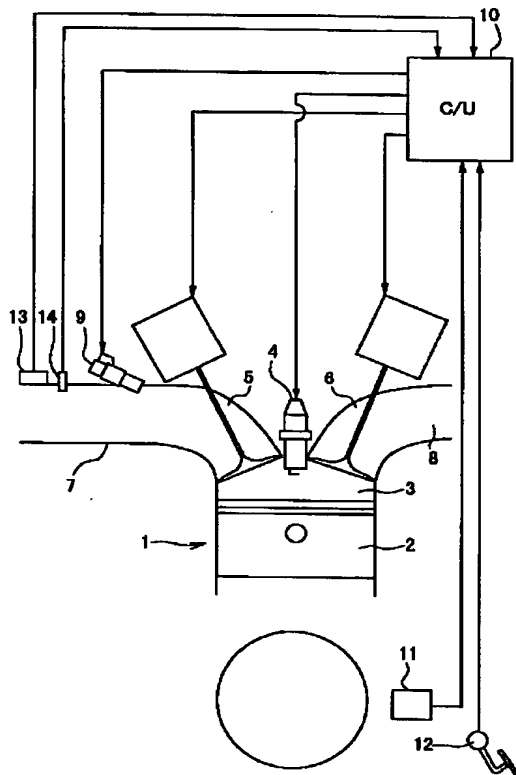
【図5】 吸・排気弁の開閉時期制御の第2の実施形態のフローチャート。

【図6】 吸・排気弁の開閉時期制御の第3の実施形態のフローチャート。

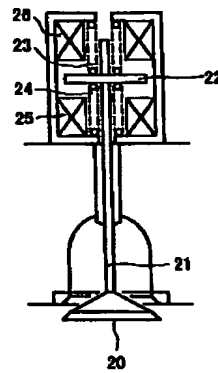
#### 【符号の説明】

- 1 エンジン
- 5 吸気弁
- 6 排気弁
- 8 排気通路
- 9 燃料噴射弁
- 10 コントロールユニット
- 11 クランク角センサ

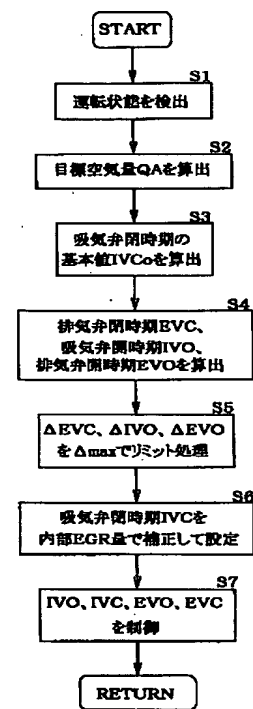
【図1】



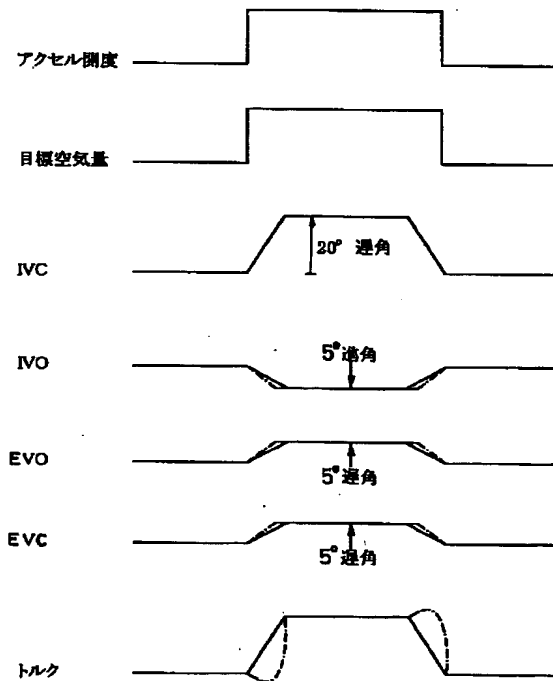
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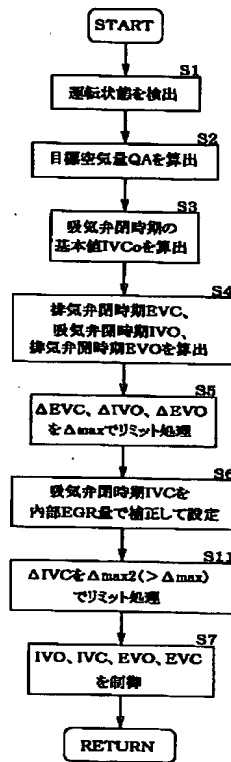
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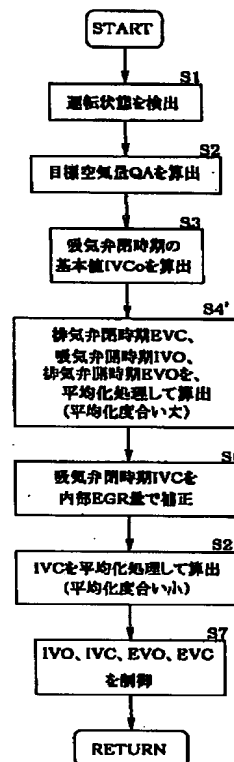
【図4】



【図5】



【図6】



フロントページの続き

Fターム(参考) 3G092 AA01 AA06 AA11 BA01 DA01  
 DA02 DA07 DA12 DD03 DG02  
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(71) Applicant: **NISSAN MOTOR CO LTD**

(72) Inventor: **KAWASAKI HISAO  
ARAI KATSUHIRO**

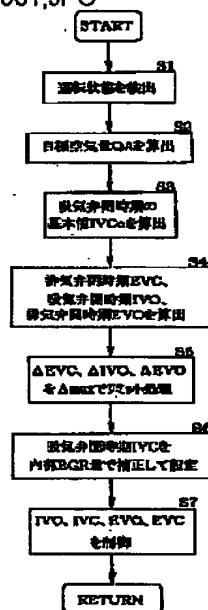
(54) **CONTROL DEVICE FOR ADJUSTABLE VALVE**

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(57) Abstract:

PROBLEM TO BE SOLVED: To improve transient performance of an engine.

SOLUTION: In an engine having electromagnetically driven intake and exhaust valve, the fundamental value IVC<sub>0</sub> of the closing timing of the intake valve is calculated according to a target air amount QA (S1-S3). After the closing timing EVC of the exhaust valve, the opening timing IVO of the intake valve, and the opening timing EVO of the exhaust valve are calculated, limit treatment is effected on  $\Delta EVC$ ,  $\Delta IVO$ , and  $\Delta EVO$  by  $\Delta \max$  (S4 and S5), and after the IVC is corrected by an internal part EGR amount and set, IVO, IVC, EVO, and EVC are controlled. This constitution decreases the change speed of a valve timing except an intake valve closing timing to a value lower than the change speed of an intake valve closing timing and improves torque performance at a transient time.



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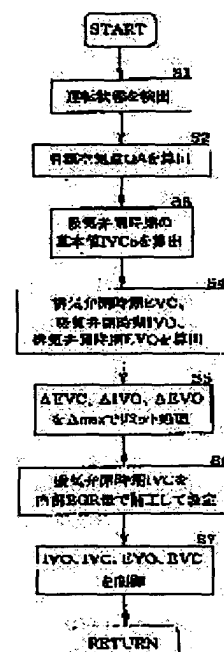
(1)Application number : 11-344214 (71)Applicant : NISSAN MOTOR CO LTD  
(2)Date of filing : 03.12.1999 (72)Inventor : KAWASAKI HISAO  
ARAI KATSUHIRO

## (4) CONTROL DEVICE FOR ADJUSTABLE VALVE

### (7)Abstract:

PROBLEM TO BE SOLVED: To improve transient performance of an engine.

SOLUTION: In an engine having electromagnetically driven intake and exhaust valve, the fundamental value IVC<sub>0</sub> of the closing timing of the intake valve is calculated according to a target air amount Q<sub>A</sub> (S1-S3). After the closing timing EVC of the exhaust valve, the opening timing IVO of the intake valve, and the opening timing EVO of the exhaust valve are calculated, limit treatment is effected on  $\Delta$  EVC,  $\Delta$  IVO, and  $\Delta$  EVO by  $\Delta$  max (S4 and S5), and after the IVC is corrected by an internal part EGR amount and set, IVO, IVC, EVO, and EVC are controlled. This constitution increases the change speed of a valve timing except an intake valve closing timing to a value lower than the change speed of an intake valve closing timing and improves torque performance at a transient time.



## LEGAL STATUS

Date of request for examination] 27.09.2002

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Date of requesting appeal against examiner's decision of rejection]



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LAIMS

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Claim(s)]

Claim 1] The control unit of the good change valve characterized by setting the change speed of the open time of an inlet valve, the open time of an exhaust valve, and closed time as a value smaller than the change speed of the closed time of an inlet valve in the control unit of the good change valve which can carry out adjustable control of the opening-and-closing time of the \*\* and the exhaust valve of an engine arbitrarily.

Claim 2] The control unit of the good change valve according to claim 1 characterized by preparing a upper limit in the change speed of the open time of an inlet valve, the open time of an exhaust valve, and closed time.

Claim 3] The control unit of the good change valve according to claim 1 characterized by making smaller than the upper limit of the change speed prepared at the closed time of an inlet valve the upper limit prepared in the change speed of the open time of an inlet valve, the open time of an exhaust valve, and closed time.

Claim 4] The control unit of the good change valve according to claim 1 characterized by making the open time of an inlet valve, the open time of an exhaust valve, and the equalization degree of closed time calculation larger than inlet-valve close time.

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[translation done.]

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## DETAILED DESCRIPTION

## Detailed Description of the Invention]

001] In the technical field to which invention belongs] this invention -- electromagnetism -- it is related with the control unit which adjusts the torque of the good change valve engine equipped with \*\* and the exhaust valve which can carry out justable control of the opening-and-closing stages, such as a drive formula, arbitrarily

002] Description of the Prior Art] although an inhalation air content is controlled by opening of a throttle valve with the engine of the general former -- recent years and electromagnetism -- it has \*\* and the exhaust valve of a drive formula, and what mainly controlled the inhalation air content by control of the closed stage of an inlet valve is proposed (refer JP,10-37727,A).

003] It is controllable by controlling by inhalation air-content control of this kind the amount of volume of the cylinder inhalation air according to the effective intake stroke determined by the closed stage of an inlet valve to the MAP according to throttle-valve opening, when using together the MAP maintained by abbreviation atmospheric pressure when it does not have a throttle valve, and a throttle valve to acquire the target air content according to demand torque.

004] Problem(s) to be Solved by the Invention] However, it is necessary to bring a closed stage close to an inhalation-of-air bottom dead point, and to increase an effective intake stroke, so that the inlet-valve close stage for acquiring a target air content according to the amount of residual gas of a combustion chamber correctly changes and the amount of residual gas increases. Therefore, the closed stage of an exhaust valve and the open stage of an inlet valve to determine the amount of residual gas are taken into consideration (also taking the open stage of an exhaust valve into consideration to accuracy). It is required that the closed stage of an inlet valve should be computed.

005] In this case, if each valve timing of \*\* and an exhaust valve is controlled equally For example, if the control of one other than the closed stage of exhaust valves other than an inlet-valve close stage, the open stage of an inlet valve, and the closed stage of the inlet valve which includes the open stage of an exhaust valve further is performed with sufficient responsibility from control of the closed stage of an inlet valve to change of the amount of residual gas the gap of the torque in a transient until the closed stage of an inlet valve is controlled by desired value became large, and might be unable to secure good operability.

006] For example, changing the open stage of an inlet valve, the closed stage of an exhaust valve, and also the open stage of an exhaust valve, when performing control which increases an inhalation air content, maintaining the rate of an internal EGR uniformly Although control which delays the closed stage of an inlet valve will be performed to an increased part of an inhalation air content in consideration of an increased part of the amount of internal EGRs (the amount of residual gas) If change of the closed stage of an inlet valve is overdue to change of the open stage of an inlet valve, the closed stage of an exhaust valve, and the open stage of an exhaust valve, inhalation air contents will run short to increase of the amount of residual gas, it will become insufficient [ torque ], and operability will fall greatly.

007] namely, the open stage of the inlet valve which determines the amount of internal EGRs (the amount of residual gas) so that change of the amount of internal EGRs (the amount of residual gas) may be followed and the always optimal air content (new \*\*\*\*) can be secured and the closed stage of an exhaust valve -- it is necessary to make responsibility of control of the open stage of an exhaust valve further lower than the responsibility of closed stage control of an inlet valve

008] this invention was made paying attention to such a conventional technical problem, and aims at offering the \*\*\* control unit of a good change valve with which the good transient performance was obtained by setting up appropriately the responsibility of each valve timing of \*\* and an exhaust valve.

009]

Means for Solving the Problem] For this reason, invention concerning a claim 1 is characterized by setting the change speed of the open stage of an inlet valve, the open stage of an exhaust valve, and a closed stage as a value smaller than the change speed of the closed stage of an inlet valve in the control unit of the good change valve which can carry out justable control of the opening-and-closing stage of the \*\* and the exhaust valve of an engine arbitrarily.

010] If the desired value of the open stage of an inlet valve, the open stage of an exhaust valve, and a closed stage is changed, although the desired value of the closed stage of an inlet valve will also be changed according to the change of the amount of residual gas according to this change according to invention concerning a claim 1, the change speed of the valve timing which participates in change of the amounts of residual gas other than an inlet-valve close stage is controlled smaller than the change speed of the closed stage of an inlet valve.

011] the control which follows change of the amount of residual gas and maintains a target air content to an optimum value by this -- it can carry out -- an inhalation air-content system highly precise also to a transient -- as a result, a torque control can be performed, a rapid torque change can be avoided, and good operability can be maintained

012] Moreover, invention concerning a claim 2 is characterized by preparing a upper limit in the change speed of the open stage of an inlet valve, the open stage of an exhaust valve, and a closed stage.

013] According to invention concerning a claim 2, the change speed of the open stage of an inlet valve, the open stage of an exhaust valve, and a closed stage is regulated by the upper limit, and is controlled smaller than the change speed of the closed stage of an inlet valve.

014] Moreover, invention concerning a claim 3 is characterized by making smaller than the upper limit of the change speed prepared at the closed stage of an inlet valve the upper limit prepared in the change speed of the open stage of an inlet valve, the open stage of an exhaust valve, and a closed stage.

015] According to invention concerning a claim 3, the change speed of the open stage of an inlet valve, the open stage of an exhaust valve, and a closed stage is controlled smaller than the change speed of the closed stage of an inlet valve by setting up the upper limit of these change speed smaller than the upper limit of the change speed of the closed stage of an inlet valve.

016] Moreover, invention concerning a claim 4 is characterized by making the open stage of an inlet valve, the open stage of an exhaust valve, and the equalization degree of closed stage calculation larger than an inlet-valve close stage.

017] If equalization processing is performed to a control-objectives value in order to avoid the transitional change by the noise etc. according to invention concerning a claim 4, it will have delay in convergence to desired value, and the delay of convergence to desired value will become large by making the equalization degree of calculation of the open stage of an inlet valve, the open stage of an exhaust valve, and a closed stage larger than an inlet-valve close stage.

018] Thereby, change speed of the open stage of an inlet valve, the open stage of an exhaust valve, and a closed stage can be made smaller than the change speed of an inlet-valve close stage.

019]

Embodiments of the Invention] The gestalt of operation of this invention is explained below. Drawing 1 is the system part of the engine equipped with the control unit of a good change valve in which 1 operation gestalt of this invention is shown.

020] an ignition plug 4 is surrounded in the combustion chamber 3 formed by the piston 2 of each cylinder of an engine 1 -- as -- electromagnetism -- it has the inlet valve 5 and exhaust valve 6 of a drive formula 7 is an inhalation-f-air path and 8 is a flueway.

021] the electromagnetism of an inlet valve 5 and an exhaust valve 6 -- driving gear (a good change valve is constituted with \*\* and an exhaust valve) Basic structure is shown in drawing 2 . The plate-like needle 22 is attached to the valve stem 21 of a valve element 20, and this needle 22 is energized by the center valve position with springs 23 and 24. this needle 22 bottom -- the object for valve opening -- electromagnetism -- a coil 25 arranges -- having -- a top the object for valve closing -- electromagnetism -- the coil 26 is arranged

022] and before starting of an engine 1 -- the object for these valve opening -- electromagnetism -- a coil 25 and the object for valve closing -- electromagnetism -- the place where the coil 26 was energized by turns at, the needle 22 was resonated at, and an amplitude became sufficiently large -- one of electromagnetism -- adsorption maintenance of the needle 22 is carried out at a coil

023] the object for valve closing of the bottom which is adsorbing the needle 22 in case it is made to open from valve closing after that -- electromagnetism -- after stopping the energization to a coil 26, a needle 22 is caudad moved by the energization force of a spring 23 -- making -- the object for lower valve opening -- electromagnetism -- this object for valve opening from a place that approached the coil 25 enough -- electromagnetism -- the lift of the valve element 20 is carried out, and it is made to open by energizing a coil 25 and adsorbing a needle 22

024] on the contrary, the object for valve opening of the bottom which is adsorbing the needle 22 in case the valve is

ade to close from valve opening -- electromagnetism -- after stopping the energization to a coil 25, a needle 22 is moved upwards by the energization force of a spring 24 -- making -- the object for upper valve closing -- electromagnetism -- this object for valve closing from a place that approached the coil 26 enough -- electromagnetism -- the sheet section is sat and a valve element 20 is made to close by energizing a coil 26 and adsorbing a needle 22

025] It returns to drawing 1 and the electromagnetic fuel injection valve 9 is formed in the inhalation-of-air path 7 at the suction-port portion for every cylinder. In here, the operation of an inlet valve 5, an exhaust valve 6, a fuel injection valve 9, and an ignition plug 4 is controlled by the control unit 10, synchronizing with engine rotation, a crank angle signal is outputted to this control unit 10, and the crank angle sensor 11 which can detect an engine speed by this, and an accelerator pedal sensor which detects accelerator opening (amount of trodding of accelerator pedal) 12 grade to the signal is inputted into it.

026] And target torque is generated based on the service condition of engines, such as accelerator opening and an engine speed, and the target opening-and-closing stage of an inlet valve 5 and an exhaust valve 6 is set up so that it may be controlled by the moderate amount of internal EGRs according to a service condition for exhaust air emission, specially NOx discharge reduction, and the opening-and-closing stage of an inlet valve 5 and an exhaust valve 6 is controlled so that this target opening-and-closing stage is obtained.

027] Moreover, based on the value detected by the various aforementioned sensors, an inhalation air content is detected and the fuel oil consumption from the aforementioned fuel injection valve 9 is controlled based on this inhalation air content. Below, the 1st operation gestalt of opening-and-closing stage control of \*\* and the exhaust valve concerning this invention is explained in detail according to the flow chart of drawing 3.

028] At Step 1, the engine speed detected by the accelerator opening and the crank angle sensor 11 which were detected by the accelerator pedal sensor 12 is read, and the operational status of an engine 1 is detected.

029] At Step 2, the target air content QA corresponding to demand torque is computed based on the operational status by which detection was carried out [ aforementioned ]. At Step 3, the basic value IVCo of the closed stage of the inlet valve 5 for acquiring the aforementioned target air content QA is set up. This basic value IVCo is set up as a value which does not take into consideration the amount of internal EGRs (the amount of residual gas).

030] The closed stage EVC of an exhaust valve 6 and the open stage IVO of an inlet valve 5 to determine the amount of bulb overlap to control the amount of internal EGRs by Step 4 in optimum dose based on the operational status by which detection was carried out [ aforementioned ] are set up, and further, the open stage EVO of an exhaust valve 6 is set up so that the open period of the required exhaust valve 6 may be secured according to the closed stage EVC of this exhaust valve 6. In addition, the open stage EVO of an exhaust valve 6 also participates in the amount of internal EGRs in relation to exhaust air (scavenging air) efficiency.

031] At Step 5, the variation delta IVO, delta EVC, and delta EVO from the last set point of Above IVO, EVC, and EVO performs limit processing which restricts variation so that upper-limit deltamax may not be exceeded.

032] At Step 6, the closed stage IVC which amended the basic value IVCo of the aforementioned inlet-valve 5 close stage in consideration of the amount of internal EGRs according to the aforementioned operational status is set up. The control signal according to the closed stage IVC of the inlet valve 5 set up as mentioned above, and the closed stage EVC and the open stage IVO of an inlet valve 5 is outputted, and the opening-and-closing stage of \*\* and an exhaust valve is controlled by Step 7. [ the open stage EVO of the exhaust valve 6 by which limit processing was carried out, and ]

033] If it does in this way, about the open stage EVO of the exhaust valve 6 which participates in the amount of internal EGRs, and the closed stage EVC and the open stage IVO of an inlet valve 5, change speed will be late controlled by limit processing by upper-limit deltamax as compared with the closed stage IVC of an inlet valve 5.

034] It performs control which carries out 20-degree angle of delay of the closed stage IVC of an inlet valve 5, and slows down by returning to the value before accelerating each valve timing after that while drawing 4 shows the sample of control at the time of acceleration and deceleration, carries out the angle of delay of every 5 degrees of the open stages EVO and the closed stages EVC of an exhaust valve 6 at the time of acceleration, carries out 5-degree both lead angle of the open stage IVO of an inlet valve 5 and increases the amount of bulb overlap by 10 degrees.

035] As shown in an illustration solid line, the change speed of the closed stage IVC of an inlet valve 5 can be completed as a policy objective value by making it larger than the change speed of the other valve timing IVO, EVC, and EVO, while IVC follows change of IVO, EVC, and EVO good also by the transient. Moreover, since it only becomes large towards being in agreement in the increase and decrease of the direction of demand torque though range of the closed stage IVC of an inlet valve 5 when torque sensitivity is large may be too earlier than change of each valve timing with the other small torque sensitivity to a transient, there is no sense of incongruity. On the contrary, since it will once be controlled in the increase and decrease of the direction of demand torque, and the direction of a retrose when change of the closed stage IVC of an inlet valve 5 is slower than change of each other valve

ning IVO, EVC, and EVO to a transient, sense of incongruity is large (refer to illustration alternate long and short dash line). It can avoid such a problem in this invention that control of an inlet-valve close stage is late for increase of residual gas, and actual torque decreases although especially demand torque is increasing, although it is a big problem. [036] Next, the flow of the 2nd operation gestalt of opening-and-closing stage control of \*\* and the exhaust valve concerning this invention is shown in drawing 5. Although Step 1 - Step 6 are the same as that of drawing 3, and offering performs limit processing which restricts variation so that upper-limit  $\Delta_{\text{max2}}$  may not be exceeded in Step 1 to variation  $\Delta_{\text{IVC}}$  to the last set point of the closed stage of the inlet valve 5 set up at Step 6 Upper-limit  $\Delta_{\text{max2}}$  of \*\*  $\Delta_{\text{IVC}}$  is a point set as the larger value than upper-limit  $\Delta_{\text{max}}$  set up to Variation  $\Delta_{\text{IVO}}$ ,  $\Delta_{\text{EVC}}$ , and  $\Delta_{\text{EVO}}$  in Step 5.

[037] Thus, since the change speed of valve timing other than the closed stage of an inlet valve 5 is smaller [ than the change speed of the closed stage of an inlet valve 5 ] controllable also as upper-limit  $\Delta_{\text{max2}} > \Delta_{\text{IVO}}$  of  $\Delta_{\text{IVC}}$ , and upper-limit  $\Delta_{\text{max}}$  of  $\Delta_{\text{EVC}}$  and  $\Delta_{\text{EVO}}$ , a rapid torque change is suppressed and smooth performance can be secured because can perform a highly precise torque control also in a transient and  $\Delta_{\text{IVC}}$  also carries out limit processing.

[038] Moreover, it is good also as composition which sets up a upper limit-like proportionally to the variation of desired value for every valve timing so that convergence to the desired value of the closed stage IVC of an inlet valve 5 and convergence to the desired value of the other valve timing IVO, EVC, and EVO may be performed to abbreviation \*\*\*.

[039] Drawing 6 shows the flow of the 3rd operation gestalt of opening-and-closing stage control of \*\* and the exhaust valve concerning this invention. With this operation gestalt, instead of limit processing, at the time of calculation of the open stage IVO of the inlet valve 5 in step 4', the closed stage EVC of an exhaust valve 6, and the open stage EVO Although equalization processing of a weighted average operation etc. is performed in Step 21 after amendment of the closed stage IVC of the inlet valve 5 according to the amount of internal EGRs in Step 6 in order to avoid the transitional change by the noise etc. The equalization degree (annealing degree) in calculation of the open stage IVO of an inlet valve 5, the closed stage EVC of an exhaust valve 6, and the open stage EVO is made larger than the equalization degree in calculation of the closed stage IVC of an inlet valve 5 (in the case of a weighted average operation, weight to the past value is enlarged more).

[040] When equalization processing is performed, it has delay in convergence to desired value. Thus, the open stage IVO of an inlet valve 5, The equalization degree of calculation of the open stage EVO of an exhaust valve 6, and the closed stage EVC by making it larger than the equalization degree of closed stage IVC calculation of an inlet valve 5 the delay of convergence to desired value becomes large, change speed of the open stage IVO of an inlet valve 5, the open stage EVO of an exhaust valve 6, and the closed stage EVC can be made smaller than the change speed of the inlet-valve 5 close stage IVC, and the same effect as the 1st and 2nd operation gestalt is acquired.

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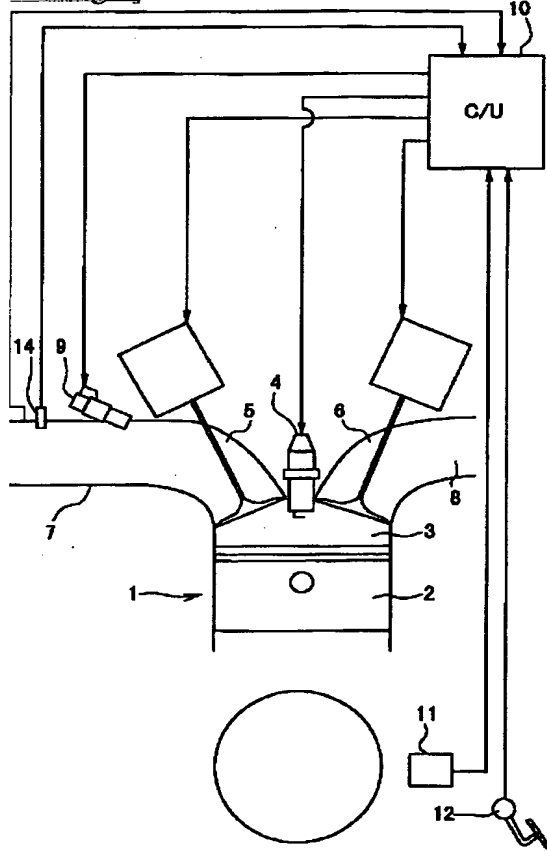
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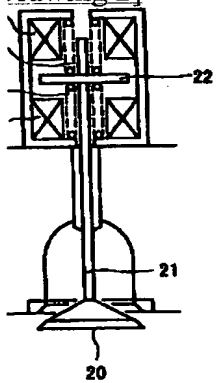
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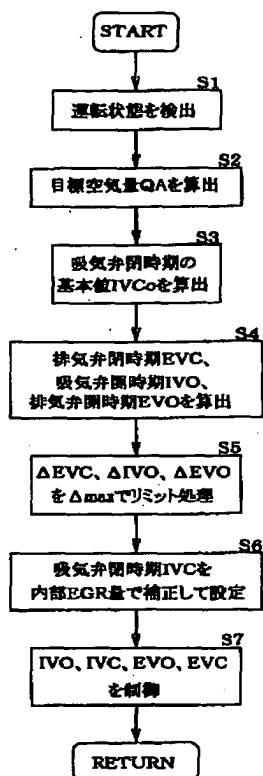
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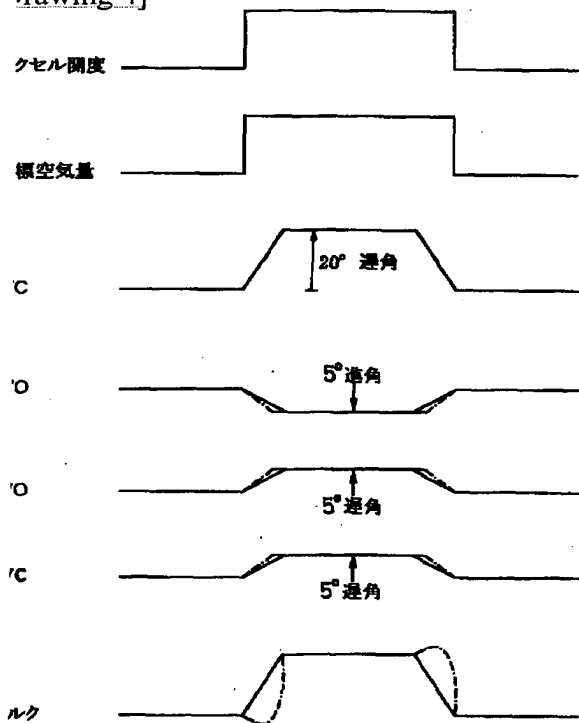
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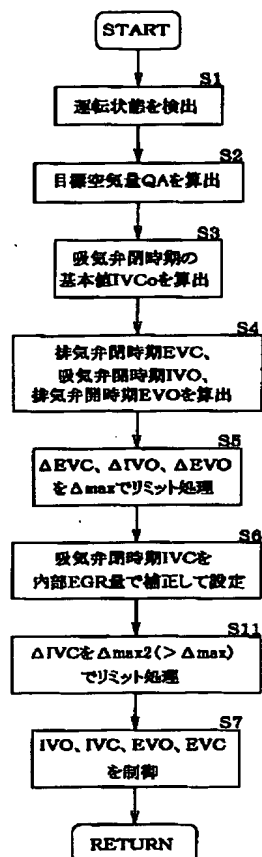
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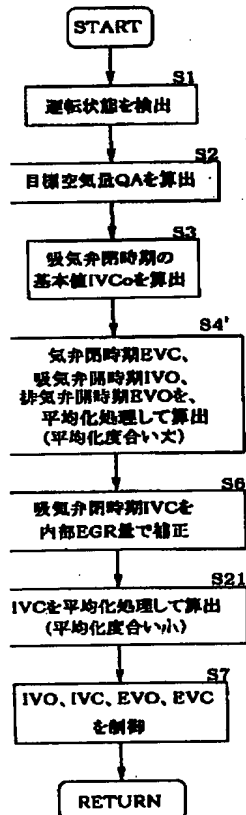
Drawing 4]



Drawing 5]



Drawing 6]





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ranslation done.]